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REVIEW OF MR. BARRANDE
ON THE
PRIMORDIAL ZONE IN NORTH AMERICA,
AND THE
TACONIC SYSTEM OF DR. EMMONS.

BY T. STERRY HUNT, M.A., F.R.S.

We are indebted to the courtesy of the author for a copy of his paper on this subject, extracted from the 18th volume of the Bulletin of the Geological Society of France, and including three communications made to that Society, November 5 and November 19, 1860, and February 4, 1861. The communications of Sir W. E. Logan, and of Mr. Billings, which have appeared in the *Naturalist*, have already made our readers acquainted with the most important facts bearing on the question before us, and we may also refer to our paper on American Geology in the April number, written before the reception of Mr. Barrande's memoir. This the author has divided into eight chapters, in the first four of which he discusses the evidences of a primordial fauna in Canada, Vermont, Tennessee, Texas and Nebraska. Our readers are already aware that in 1859, Mr. Hall described three species of *Olenus* from Georgia, Vermont, besides which the observations of Roemer, Shumard, and Safford, have shown the existence of related genera, in Tennessee, Nebraska and Texas, where they occur in strata which are recognized by these authors as being at the base of the palaeozoic series. The observations of Mr. Barrande upon the remarkable fauna from Point Levis, are so important that we translate them at

length, referring to Mr. Billings's description of the four groups of fossils, which will be found in the *Naturalist* for August 1860, Vol. V., p. 301.

"The group No. 1 is distinguished from all the others by several very remarkable characteristics. Of the eight genera of fossils, two are brachiopods and six trilobites, so that the latter furnish three-fourths of the types of the group. If we compare the species, the brachiopods are three and the trilobites eighteen in number, or six-sevenths of the known species of the group. These numerical relations, indicating a great predominance of trilobites, recall in a striking manner one of the principal characters of the primordial fauna.

"Among the trilobitic types are four forms which up to the present time, have been found to belong exclusively to the primordial fauna; namely, *Concephalites*, *Arionellus*, *Menocephalus* and *Dikellocephalus*; besides which the genus *Agnostus* furnishes three distinct species, in place of the single one which is found in the group No. 2.

"The two genera, *Lingula* and *Discina*, which complete the fauna of the first group, are among those which are found in the primordial fauna almost everywhere that it has been observed; but here, as elsewhere, the number of species of these genera is very limited.

"With these facts before us, it would be impossible, from a palaeontological point of view, not to recognize the primordial fauna in the group No. 1. It will be understood that if for the time being, we neglect all other considerations, it is because stratigraphy has not as yet furnished any facts which can be appealed to for the solution of the question.

"We will now compare the fossils of the 2nd group. They consist of seventeen genera, of which only three are trilobites; of these two, *Agnostus* and *Bathyrurus*, occur in the first group, while *Cheirurus* is here met with for the first time, so that the crustaceans have no longer the great predominance which is apparent in the preceding group. Besides *Cheirurus* is a type which has never yet been observed in any country earlier than the second fauna, and the same is true of the genus *Amphion*, of which Mr. Billings thinks he has discovered a pygidium which is figured in his memoir, although the genus is not mentioned in the list which he has given. On the other hand, we know that *Agnostus*, although it ascends to the summit of the second fauna,

never goes above it, so that the crustaceans of the second group taken together, represent the second fauna.

"The cephalopods are here represented by the two genera, *Orthoceras* and *Cyrtoceras*, furnishing together nine species, and we may remark that the species of the latter genus, four in number, are relatively numerous for such a horizon. Now the cephalopods, which are not rare in the second fauna, have never been observed in the primordial fauna. In the table which we published in 1859 (*Bull. of the Geol. Society of June, XVI. 543*), we have it is true indicated, with a doubt, the presence of an *Orthoceras* in the primordial fauna of Scandinavia. We however take advantage of the present occasion to correct this indication, which as we have mentioned in our *Parallels* p. 43, was furnished by Mr. Angelin. This savant, who is now with us, informs us that he has lately established in the most positive manner, that the orthoceratite in question really occurs in his region *B C*—*Ceratopygarum*, that is to say in the alum slates with limestone beds, which contain the first portions of the second fauna in Sweden. In accordance with this fact, it would appear that the cephalopods indicated by Mr. Billings in his 2nd group must be referred to the second fauna.

"The gasteropods furnish to the second group six genera, which are commonly found in the second fauna of various countries, but as these types are reproduced in the third fauna, their presence here has no bearing upon the question before us.

"The acephala are only represented by the new genus *Cyrtodonta* lately established by Mr. Billings, according to whom the eleven species of this genus already described, belong to the Black River and Trenton limestones, i. e., to the second fauna of Canada, although allied forms may also occur in the third fauna. (*Canadian Naturalist*, December 1858, p. 331.)

"The class of brachiopods, which is relatively but little developed, offers four genera, *Lingula*, *Orthis*, *Strophomena* and *Camarella*, which last genus was founded by Mr. Billings in 1859, to include several species of the second fauna of Canada, (*Canadian Naturalist*, August, 1859, p. 301). Nothing however indicates that similar forms may not also occur in the third fauna, as is the case with the three other genera mentioned. Thus the fossils of this class, generically considered, establish nothing as to the geological horizon of the second group, although it is very

probable that the study of their specific forms may aid us in finding its horizon.

"The bryozoa furnish to the second group a form of *Dictyonema*; a type which although signalized in the Primordial Zone of different countries, does not appear to be confined to that horizon. The specific nature of the form in question has not yet been determined.

"In conclusion we may say that the association of *Agnostus* with the various other genera which we have just passed in review, seems to shew in a positive manner that the second group belongs to the second fauna. This conclusion may be extended with still greater reason to the group No. 3, which contains only the genus *Asaphus*, represented by two species. This type has never been signalized either above or below the second fauna, of which it constitutes one of the most marked and most constant characters. The second and third groups considered palaeontologically, then represent simply phases of the second fauna.

"The 4th group only containing two types, *Orthis* and *Tetradium*; the latter, a polyp, presents no certain sign enabling us to give the epoch to which it belongs. The palaeontological data furnished by Mr. Billings, considered apart from the stratigraphical relations yet to be determined between the four groups, lead us to recognize the existence both of the primordial and the second fauna in the calcareous rocks of Point Levis. It is important to remark that these faunas, although occurring in beds very near each other, have as yet offered but few evidences of connection, since Mr. Billings has only indicated two species common to the groups 1 and 2.

"Such are the only deductions which we believe ourselves entitled to draw from the interesting facts above mentioned. We do not wish to pass the limits of the most prudent reserve in the case, because the facts briefly expressed by Mr. Billings in the introduction of his descriptions of the Point Levis fossils, indicate that there are some difficulties yet to be resolved. We observe in the first place, that all these limestones, without distinction, are indicated as being intercalated in a great schistose formation, which has furnished about thirty forms of graptolites, and other analogous fossils, with two *Lingulas*, one *Orthis*, one *Discina*, and one small unknown trilobite. It would be very important to

establish whether the species belonging to these schists are found indifferently at various heights, above, below and between the limestones. Without very precise observations to determine and limit the distribution and the extension of these fossils in the schists, it would be impossible to form an exact idea of the relations which may exist between the representatives of the first and second faunas contained in these limestones.

"In the second place, the introduction of Mr. Billings concludes by the following passage which merits special attention. 'It is not yet certain whether the fossils of the limestones are included in the boulders or the paste of the conglomerate.' There exist then in the limestones in question, two rocks of different origins, the one represented by boulders, which we may suppose to have been transported from a distance, and the other formed upon the spot by ordinary sedimentation. While waiting for light upon these points, we will add the following considerations :

"I. It is established by Mr. Billings that the four groups of fossils are each enclosed in a rock distinct in appearance, and that these rocks form different beds, between which there are yet but very few species in common. With these facts, even if it should one day be proved that the fossils belong to the broken and transported fragments of rock which enter into the conglomerate, it will not be less true that the primordial and secondary faunas must have belonged to separate formations in the region which furnished the transported materials, for it is evident that if these fossil species had been originally mingled in a common formation, no physical cause could have assorted and separated them, so as to form the two distinct groups which represent the primordial and secondary faunas in the rocks at Point Levis.

"II. We must also remark that if any admixture of the species of the two faunas should ultimately be found in these conglomerates near Quebec, it would in no wise prove that there had been a similar commingling in the locality which had furnished the boulders of these conglomerates, for the fact of their having been transported, would of itself suffice to explain such an apparent co-existence or confusion of the two faunas."

In the fifth chapter Mr. Barrande discusses the Taconic system of Dr. Emmons. This geologist, while engaged in the survey of a part of the State of New York, recognized the existence of a series of sedimentary rocks, which he regarded as older than those supposed by his colleagues to represent the Silurian series.

A similar view had been maintained by Eaton, but was rejected by most of the American geologists, who up to this time have regarded these Taconic rocks of Emmons as belonging to the Lower Silurian series. In 1844 Dr. Emmons described certain fossils from these rocks, which he supposed to be new and to distinguish what he called the Taconic system, regarded by him as the true palaeozoic base. In 1846 Mr. Barrande discovered in Bohemia, beneath the horizon of the hitherto recognized Silurian fossils, a new and extensive fauna in what he designated the Primordial Zone. The fossils described by Dr. Emmons consisted, besides some imperfect trilobites, of a few graptolites, mistaken by him for fucoids, and several very doubtful forms which are valueless for the purpose of determination. According to Dr. Emmons this system, which he divides into an upper and lower portion, has a thickness of 30,000 feet, and extends throughout the whole Appalachian chain. He has described it as composed in ascending order of, 1. Granular quartz; 2. The Stockbridge limestone; 3. Magnesian slates; 4. Sparry limestone; 5. Roofing slates (graptolitic); 6. Silicious conglomerate; 7. Taconic slates; 8. Black slates. This is not their apparent order of superposition, but Dr. Emmons conceives that the whole series has been inverted since its deposition. In fact the schistose strata 5, 6, 7 and 8, pass successively beneath the magnesian slates and limestones, which in their turn are overlaid to the east by the Green Mountain gneiss. This latter formation Dr. Emmons regards as a primitive azoic rock, upon which were successively deposited the members of the Taconic system, commencing with the quartzite, which forms its base, and crowned by the black and Taconic slates, which are now, from an immense overturn, placed at the bottom of the series, while the ancient gneiss lies at the top. It is hardly necessary to say that this supposition is wholly unwarranted by the facts. In the paper on American geology already cited, we have shown that the apparent succession of the rocks of the Quebec group is the true one. The black slates are really at its base and successively overlaid by the conglomerates, roofing slates, limestones and quartzites, and the gneiss is a newer rock, being no other than the Sillery sandstone in an altered condition, and as we have there shewn, entirely distinct from the Laurentian gneiss. Dr. Emmons has fallen into an error, similar to that of Prof. Nichol with regard to the gneiss of the Scottish Highlands, so well refuted by Murchison, Ramsay and Harkness, and has consequently been driven, in order to explain the

structure of the Green Mts. to admit not merely an upthrow with Nichol, but a complete overturn of the whole palaeozoic series in question. As to the geological age of this series, Dr. Emmons maintains that his Taconic system occupies a position inferior to the Champlain division of the New York system, and is consequently beneath the Lower Silurian system of Murchison. As we have before shown however, the fossils of the Quebec group prove it to be the palaeontological equivalent of the Calciferous sandrock. The Stockbridge and sparry limestones, with their accompanying slates (excepting only 7 and 8,) we conceive to be no other than the Quebec group, of which they have both the stratigraphical position and the lithological characters. Dr. Emmons has maintained that limestones of the age of the Calciferous are found overlying the black slates, and has appealed to this in proof of the antiquity of the whole series, of which he imagined these slates to form the summit, but inasmuch as these slates are really older than the Quebec or Calciferous strata, his argument falls to the ground. Mr. Billings has lately found *Conocephalites* in the red sandrock of Highgate, Vermont, which is supposed to overlie the black slates in question. As this primordial genus occurs also in the Potsdam sandstone of Lake Champlain, the question arises whether these slates are palaeontologically distinct from the Potsdam, or are only its deep sea equivalent, sustaining to the littoral formation of quartzose sandstone on Lake Champlain, the same relation as the great Quebec group does to the Calciferous sandrock of the New York geologists. Dr. Emmons claims that the whole of his Taconic system is inferior to the Potsdam sandstone, which is the admitted base of the Champlain division, but we have already shown that the whole of his system, with the probable exception of these slates, is of the age of the Calciferous sandrock, the second member of that division. Unless then these lower black slates contain a fauna distinct from and older than that of the Potsdam sandstone, there remains absolutely nothing of the Taconic system which Dr. Emmons placed below the base of the Champlain division, that is to say, below the Potsdam sandstone. If, however, as is probable, these slates contain a fauna distinct from the Potsdam, they might be retained under the name of the Taconic formation, as a lower member of the Primordial Zone, to which the Potsdam sandstone unquestionably belongs.

These lower slates in Georgia, Vermont, have as already remarked

furnished certain trilobites of primordial type which Mr. James Hall has described under the name of *Olenus Vermontana* and *Olenus Thompsoni*, though they are provisionally referred by Barrande to the genus *Paradoxides*. In the meantime the only trilobite as yet met with in the typical Potsdam sandstone of this region, which is rarely fossiliferous, is *Conocephalites*.* A collection of fossils recently made by Mr. James Richardson in exploring the Straits of Bellisle for the Geological Survey of Canada, fortunately furnishes the means of determining the relations of the trilobites described by Mr. Hall. On the north side of the Straits he found reposing on the Laurentian rocks a coarse reddish sandstone holding *Scolithus* like that from the Primal sandstone of Pennsylvania. Resting upon this, and dipping gently southward, is a limestone in which occur both *Olenus Thompsoni* and *O. Vermontana*, with what appears to be an *Arionellus*, besides *Obolus*, *Capulus*, and a large spirally marked coral resembling *Zaphrentis*. These rocks, which evidently represent the Primordial Zone, are overlaid by others containing the characteristic fossils of the Calciferous sandrock and the compound graptolites of the Quebec group. These primordial trilobites then overlie the sandstone with *Scolithus*, but as we have elsewhere observed, that species appears unlike the *Scolithus* from the Potsdam of Lake Champlain, and should not be too much relied upon for fixing the geological age of this formation. It is not improbable that the true equivalent of the *Conocephalites* and *Lingula* sandstones of Lake Champlain will be found in some of the strata above the *Olenus* beds of Bellisle.

We have seen that Emmons, guided by a false notion of the age of the Green Mountain gneiss which led him to admit an inversion of the whole series, placed the shales which form a portion of the Primordial Zone high in the second fauna, above the whole Quebec group. On entirely different ground, Hall assigned the shale containing *Olenus*—two species of which genus he described in 1847 in the 1st Vol. of the Palaeontology of New York,—to the Hudson group. In this, as Barrande shows, Mr. Hall felt himself justified by the authority of Hisinger, who in his great work on the fossils

* Mr. Barrande refers to three species of *Dikellocephalus* indicated by Dr. Bigsby as occurring in the Potsdam of New York. It will be seen by referring to his memoir (Quar. Jour. Geol. Soc. 1858, p. 339, compared with p. 420,) that Dr. B. alludes only to the existence of these species as described by Owen in the Mississippi valley.

of Sweden, *Lethæa Suecica*, 1837, gives the succession of palæozoic rocks in Sweden as follows in ascending order; 1. Fucoidal sandstone; 2. Orthoceratite limestone; 3. Alum slates with *Olenus*; 4. Argillaceous slates with graptolites, etc.

The *Olenus* slates, said by Hisinger to overlie the orthoceratite limestone, (corresponding to the Trenton,) Mr. Hall unhesitatingly regarded as the equivalents of the Hudson group, in which *Olenus* was to be looked for as a characteristic fossil, and hence the strata containing these trilobites were, on the authority of Hisinger, regarded as belonging to the summit of the second fauna. In reality however this order assigned by Hisinger to the formations of Sweden is false, since the alum slate with *Olenus* lies below, and the graptolitic slate above the orthoceratite limestone. This error of Hisinger is the more strange since he had long before, as Barrande shows, indicated the true succession of these rocks, and is perhaps a mistake of the copyist or printer; it is the more to be regretted as his authority had caused it to be adopted by Mr. Hall in America. (*Geol. of Lake Superior*, Foster and Whitney, II. pp. 298—318.) The alum slate with the underlying sandstone represents in Sweden the primordial zone.

To Dr. Emmons undoubtedly belongs the merit of having recognized for the first time the trilobites which are known to belong the primordial zone, although from incorrect notions of stratigraphy he placed the slates containing them at the summit of the series of rocks to which he gave the name of the Taconic system. We have shown that the true place of these shales is at the base of the series, and that the remainder of the Taconic system is the palæontological equivalent of the Calciferous sandrock; it is not yet certain whether these lower shales with a primordial fauna do not sustain a similar relation to the Potsdam sandstone, in which case the whole of the Taconic system would be the equivalent of the two lower groups of the Champlain division. It yet remains to be seen whether Dr. Emmons can retain from the wreck of his system, the lower slates as a Taconic formation older than the Potsdam sandstone of Lake Champlain, and subordinate to the Primordial Zone, whose fossils he was the first to recognize.

Mr. Barrande refers to the opinion expressed by Mr. Marcou that the rocks beneath the fall at Montmorenci, near Quebec, are Primordial, and are overlaid unconformably by the Trenton limestone found above the fall, contrary to the statement of Sir William Logan in his report for 1852-53, that these rocks are the upper

members of the Lower Silurian series, brought down by a fault. A reference to Sir William's paper in this Journal for June last, will show that the strata at the base of the fall, so far from being Primordial, contain in abundance the fossils of the Trenton and Utica formations, and that the latter may be traced over to the north side of Orleans Island, beyond which is the overlap that brings to the surface the rocks of the Quebec or Calciferous group.

Mr. Barrande then observes that "the results from the study of the Quebec group are another proof of the prompt and efficient aid which palæontology lends to geology, when local circumstances put at fault all the resources of stratigraphy." He next proceeds to analyze Sir William Logan's letter of December last, (this Journal Jan., 1861) and expresses his entire accordance with the views therein advanced, concluding with the following tribute to the labors of the Geological Survey, which we may be pardoned for reproducing.

"The vast regions of Canada have only within a few years been made known to geologists, and that they have already greatly attracted the attention of savants, is due solely to the rapid and productive labours of the Geological Commission which is charged with the survey of the country. Let us remember that one of the most honourable distinctions that France has ever accorded to geology was in 1855, conferred on this commission, that is to say, on Sir W. E. Logan who directs it, and his learned colleagues. All of us, simple laborers or volunteers in the science, then applauded these international honours, for we well knew how to appreciate the difficulties and the merits of explorations made on so vast a scale. It is therefore with gladness that we seize the opportunity now again offered us, to express to our Canadian *confrères* all our personal sympathies, and our best wishes for the successful completion of the arduous and honourable task which has been committed to them."

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